

**CLAIMS**

[1] A production method of a metal product, characterized by comprising:

5 a molding step of molding a product main body;

a defect removal step of removing a defect periphery including a defect generated on a surface to be treated of the product main body by molding after finishing the molding step so that a recess portion is formed on the surface to be treated of the product main  
10 body; and

a deposition step of gradually forming a deposition at a recess portion periphery after finishing the defect removal step by employing a molded electrode composed of a molded body molded from a powder of a metal or the molded body processed with a heat  
15 treatment, and generating a pulsing electric discharge between the recess portion periphery including the recess portion and the molded electrode in an electrically insulating liquid or gas so that a material of the molded electrode or a reaction substance of the material carries out deposition, diffusion and/or welding  
20 at the recess portion periphery by energy of the electric discharge.

[2] The production method of the metal product recited in claim 1, characterized by comprising an excessive deposition removal step of removing an excessive deposition sticking out of the recess  
25 portion in the deposition after finishing the deposition step.

[3] The production method of the metal product recited in claim 2, characterized in that the excessive deposition removal step is carried out by employing a hard electrode having exhaustion  
30 resistance and generating a pulsing discharge between the deposition and the hard electrode so that a thin film is generated as well as the excessive deposition is removed by means of energy of the electric discharge.

35 [4] The production method of the metal product recited in any claim of from claim 1 to claim 3, characterized by comprising a heat treatment step of carrying out a heat treatment with respect

to the deposition by keeping the deposition accompanying the product main body at a high temperature in a vacuum or in the air by means of a heat treatment furnace after finishing the deposition step so as to progress diffusion bonding among particles at the interior  
5 of the deposition.

[5] A production method of a metal product, characterized by comprising:

a molding step of molding a product main body;  
10 a defect removal step of removing a defect periphery including a defect generated on a surface to be treated of the product main body by molding after finishing the molding step so that a recess portion is formed on the surface to be treated of the product main body;

15 a first deposition step of gradually forming a deposition at a recess portion periphery after finishing the defect removal step by employing a molded electrode composed of a molded body molded from a powder of a metal or the molded body processed with a heat treatment, and generating a pulsing electric discharge  
20 between the recess portion periphery including the recess portion and the molded electrode in an electrically insulating liquid or gas so that a material of the molded electrode or a reaction substance of the material carries out deposition, diffusion and/or welding at the recess portion periphery by means of energy of the electric  
25 discharge;

a thin film step of generating a thin film composed of a structure of high density at a surface of the deposition after finishing the first deposition step by employing a hard electrode having exhaustion resistance and generating a pulsing discharge  
30 between the deposition and the hard electrode in an electrically insulating liquid or gas so that the surface of the deposition is melted by means of energy of the electric discharge; and

a second deposition step of gradually forming a deposition group composed of two layers of depositions at the recess portion periphery after finishing the thin film step by generating a pulsing  
35 electric discharge between the thin film in the deposition and the molded electrode in an electrically insulating liquid or gas

so that a material of the molded electrode or a reaction substance of the material carries out deposition, diffusion and/or welding the thin film in the deposition by energy of the electric discharge.

- 5 [6] The production method of the metal product recited in claim 5, characterized by comprising an excessive deposition removal step of removing an excessive deposition sticking out of the recess portion in the deposition group after finishing the second deposition step.

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- [7] The production method of the metal product recited in claim 5 or claim 6, characterized by comprising a heat treatment step of carrying out a heat treatment with respect to the deposition group by keeping the deposition group accompanying the product main body at a high temperature in a vacuum or in the air by means of a heat treatment furnace after finishing the second deposition step so as to progress diffusion bonding among particles at the interior of the deposition group.

- 20 [8] A production method of a metal product, characterized by comprising:

a molding step of molding a product main body;

- a defect removal step of removing a defect periphery including a defect generated on a surface to be treated of the product main body by molding after finishing the molding step so that a recess portion is formed on the surface to be treated of the product main body;

- a deposition step of forming a deposition at a recess portion periphery after finishing the defect removal step by employing a molded electrode composed of a molded body molded from a powder of a metal or the molded body processed with a heat treatment, and generating a pulsing electric discharge between the recess portion periphery including the recess portion and the molded electrode in an electrically insulating liquid or gas so that a material of the molded electrode or a reaction substance of the material carries out deposition, diffusion and/or welding at the recess portion periphery by energy of the electric discharge;

a thin film step of generating a thin film composed of a structure of high density at a surface of the deposition after finishing the thin film step by employing the molded electrode or a hard electrode having exhaustion resistance and generating  
5 a pulsing discharge between the deposition and the molded electrode or the hard electrode in an electrically insulating liquid or gas so that the surface of the deposition is melted by means of energy of the electric discharge; and

10 a repetition step of forming the thin film at the surface of the respective layers of the depositions and gradually forming a deposition group composed of plural layers of depositions at the recess portion periphery by repeating the deposition step and the thin film step after finishing the thin film step.

15 [9] The production method of the metal product recited in claim 8, characterized by comprising an excessive deposition removal step of removing an excessive deposition sticking out of the recess portion in the deposition group after finishing the repetition  
20 step.

[10] The production method of the metal product recited in claim 8 or claim 9, characterized by comprising a heat treatment step of carrying out a heat treatment with respect to the deposition group by keeping the deposition group accompanying the product  
25 main body at a high temperature in a vacuum or in the air by means of a heat treatment furnace after finishing the deposition group step so as to progress diffusion bonding among particles at the interior of the deposition group.

30 [11] The production method of the metal product recited in any claim of from claim 1 to claim 10, characterized by employing a hard electrode having exhaustion resistance and generating a pulsing electric discharge between the surface to be treated of the product main body and the hard electrode in an electrically  
35 insulating liquid or gas so that a defect generated on the surface to be treated of the product main body is removed by means of energy of the electric discharge.

[12] The production method of the metal product recited in any claim of from claim 1 to claim 11, characterized in that the powder of the metal composing the molded body is a powder of a material  
5 having the same composition as a base material of the product main body, a powder of a material having a similar composition to the base material of the product main body, or a powder of a material having a coefficient of thermal expansion close to a coefficient of thermal expansion of the base material of the product main body.

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[13] The production method of the metal product recited in any claim of claim 3, claim 5 and claim 8, characterized in that the hard electrode is composed of a solid substance of graphite, tungsten alloys, or copper alloys.

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[14] The production method of the metal product recited in any claim of from claim 1 to claim 13, characterized in that the molding step is a step of molding the product main body by casting, and the defect is a casting cavity.

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[15] A metal product characterized by being produced by the production method of the metal product recited in any claim of from claim 1 to claim 14.

25 [16] A joining method of metal components, characterized by comprising:

a butting step of defining a recess portion by a beveling portion of one of the metal components and another beveling portion of the other of the metal components by butting the pair of the  
30 metal components; and

a deposition step of gradually forming a deposition at a recess portion periphery after finishing the butting step by employing a molded electrode composed of a molded body molded from a powder of a metal or the molded body processed with a heat treatment,  
35 and generating a pulsing electric discharge between the recess portion periphery including the recess portion and the molded electrode in an electrically insulating liquid or gas so that a

material of the molded electrode or a reaction substance of the material carries out deposition, diffusion and/or welding at the recess portion periphery by energy of the electric discharge.

5 [17] The joining method of the metal components recited in claim 16, characterized by comprising a heat treatment step of carrying out a heat treatment with respect to the deposition by keeping the deposition accompanying the product main body at a high temperature in a vacuum or in the air by means of a heat treatment  
10 furnace after finishing the deposition step so as to progress diffusion bonding among particles at the interior of the deposition.

[18] The joining method of the metal components recited in claim 16 or claim 17, characterized in that the powder of the metal  
15 composing the molded body is a powder of a material having the same composition as a base material of the metal components, a powder of a material having a similar composition to the base material of the metal components, or a powder of a material having a coefficient of thermal expansion close to a coefficient of thermal  
20 expansion of the base material of the metal components.

[19] A joint structure characterized by comprising:  
a pair of metal components respectively having beveling portions, the metal components being joined in a state of being  
25 butted with each other; and

a deposition formed at a recess portion periphery including a recess portion defined by the beveling portion of one of the metal components and the beveling portion of the other of the metal components,

30 wherein the deposition is gradually formed by employing a molded electrode composed of a molded body molded from a powder of a metal or the molded body processed with a heat treatment, and generating a pulsing electric discharge between the recess portion periphery including the recess portion and the molded  
35 electrode in an electrically insulating liquid or gas so that a material of the molded electrode or a reaction substance of the material carries out deposition, diffusion and/or welding at the

recess portion periphery by energy of the electric discharge.

[20] The joint structure recited in claim 19, characterized in that the deposition is processed with a heat treatment so as to progress diffusion bonding among particles at the interior of the deposition group.

[21] The joint structure recited in claim 20 or claim 21, characterized in that the powder of the metal composing the molded body is a powder of a material having the same composition as a base material of the metal components, a powder of a material having a similar composition to the base material of the metal components, or a powder of a material having a coefficient of thermal expansion close to a coefficient of thermal expansion of the base material of the metal components.